inter·noise 96
25th Anniversary Congress – Liverpool

INCE: 62

PROGRESS REPORT, AES WORKING GROUP (WG–11) ON MUSIC ACOUSTICAL LEVELS

D Queen

Daniel Queen Assoc, USA

In 1989, the Audio Engineering Society Standards Committee established the WG-11 Working Group on Music Acoustical levels to write standards on sound levels at which music is performed, their effects on hearing loss and on community noise complaints. The Audio Engineering Society is an internationally based professional society concerned with audio-range sound production, reproduction, transmission, and reinforcement and associated equipment. Its membership is spread uniformly through the industrial world.

The formation of group was motivated by three considerations.

1) Reports of hearing loss among musicians and audiences, particularly relating to popular music, had been received by the Audio Engineering Society and by other organizations.

2) Many complaints had been received of community annoyance attributed to music performance at outdoor venues and in residences proximal to popular-music establishments. A number of new laws had been enacted and applications of old laws were being reviewed in courts.

3) Finally, and in the light of the first two considerations, musicians and music producers wished to define reasonable and necessary levels for performance.

The working group set itself a task of writing AES25, *Acoustical levels for music performance* (partial title). The scope of the document is assessment and measurement of acoustical levels required for performance and the effects of those levels on hearing and annoyance.

To fulfill the first two motivating considerations, the group felt that it should draw on existing international standards used for measurements of hearing hazard and community noise effects. It notes some problems in that,

> Generally, such practices and standards have been developed for measurement of noise. In contrast, this standard applies these

methods while considering the unique nature of music — based on the precept that music contains desired information-bearing elements, whereas, in general, noise does not.

The group realized however, that it would have to research the question of music performance levels itself, and that this consideration would be a unique contribution that could only be made by the AES.

As a first step toward its research, the working group, in cooperation with the AES Technical Council, organized a special session at the 1991 New York, USA convention of the AES. Speakers were invited to address all the three considerations. A tutorial on measurement was presented by R.J. Peppin and F.M. Hirsh, of Scantek. Hearing loss from noise and music was discussed by W. D. Ward who indicated that a review of the relevant evidence, other than anecdotal, indicates that the risk of damage from music is minimal. J.D. Royster and L.H. Royster reported on dosimetry results from which they estimated the potential for hearing damage using ISO 1999 (1990). European regulation of high music sound levels was surveyed by J. Voetmann of the Danish Acoustical Institute. J.S. Brawley, then chair of WG-11, showed data on sound-level distributions from rock-concert sound systems.

Beginning from the results of this special session, a draft was prepared embodying the international standards. However, the very crucial question of necessary or desired music-performance levels has remained the subject of continuing research.

With regard to hearing damage, the draft recommends that

Estimates of potential damage risk shall be according to ISO 1999. Such estimates require knowledge of A-weighted sound level, duration of exposure, and a determination of an acceptable percentage of a population that may be placed at risk. Careful consideration shall be given to the spectrum of the music and its deviation from the spectrum of industrial noise upon which ISO 1999 is based. Music spectra may be assessed by comparison of A-weighted and C-weighted measurements. When the difference between the measurements exceeds 10 dB, ISO 1999 can overestimate the risk. Estimates shall differentiate the exposures of listeners from musicians, and from ancillary personnel. Risk due to headphone use can exceed ISO 1999 estimates.

With respect to community annoyance, the draft recommends that

Estimates of the risk of annoying local communities shall be made according to applicable ordinances. In the absence of applicable ordinances, estimates of potential community annoyance can be based upon ISO 1996 and on model noise ordinances.

Estimates shall be made separately in the following categories:

1) air- and structure-borne sound into residential living spaces;
2) sound levels at property lines;
3) sound levels in public areas.

Estimates shall include the effects of single occurrences of sound levels, frequency of occurrence of sound levels, and time-weighted averages of sound levels.

The issue of levels affecting outdoor performance were of concern because of actions faced by operators of outdoor music facilities. A United States Supreme Court decision *(Ward v Rock Against Racism)* reversed a lower court decision restricting use of noise ordinances for artistic expression in public areas, but left the question of reasonable levels to local jurisdictions. No relevant guidance was found in international standards.

Problems created by this lack of guidance are illustrated in the enactment of recent ordinances to meet community response to levels from music performance. Typical is the New York City Public Law 92 which supplemented the usual community noise ordinances with requirements for measurements in some third-octave bands. This ordinance is highly illustrative of the problems.

The ordinance, later incorporated into the NYC noise code as paragraph 24-241.1, was intended for controlling the levels of disco-dance clubs. The ordinance restricted levels audible in residences to 45 dB, A-weighted, and 45 dB in any of the 63 to 500 Hz third-octave bands. Thus the ordinance recognized that A-weighted measurements alone would not detect the low frequency sounds that become annoying when they regularly fluctuate — as in rhythmic music.

However, in doing so, it neglected several technical and administrative difficulties. No recognition is given of band-edge effects of the discrete-tone dominated noise source. No duration is specified in the ordinance, so a single occurrence long enough to be observed on a meter would constitute a violation. No mechanism is included for warning or for an abatement period. No access is allowed to the complainant residence for measurements either for defense or for corrective design. Fines are US$2000.00 for the first offense, US$4000.00 for the second, US$8000.00 for the third, and mandatory closure of the offending institution thereafter. Trial is by administrative hearing with court appeal possible only after the penalties have been paid. The only defense allowed at the hearing is a challenge to the accuracy of the measurements that had been made by the inspectors, although the hearing officer has the discretionary authority to reduce the fine to one-half if evidence is shown that the noise is being mitigated.

In cases in which this author has been involved, the most effective defense has been to show that the temporal patterns in the inspection reports do not match those produced by the institution, but do match other noise sources.

Often that other noise source is the ambient noise level, but more often it is another commercial institution playing or producing music. In a case where a dance club was facing a third citation, the inspector recorded a low-frequency temporal pattern that did not correspond to music being played in the club at the time, but did correspond to low-frequency sound originating in a recording studio at the opposite side of the complaining residence. However, the recording studio, being less visible, had never been cited.

In another case, a small classical-music dance school received a first-time citation. Music could be heard at a low level in a courtyard near the back of the school if the school left a door ajar for ventilation. The school was using string-quartet music from a portable cassette player. For a few seconds, a cello exceeded 45 dB, A-weighted, presumably also within an adjoining residence. Thus the school was in violation of the ordinance. During the hearing, the school showed that it subsequently properly sealed the door but the fine remained assessed.

About a year later, the school was again cited. The inspector's report showed a temporal pattern resembling disco music, but no such pattern existed for sound from the school. In reality, the pattern was that of disco music from a commercial exercise gymnasium on the floor below. The citation was thrown out. Nevertheless the school had been burdened with considerable expense in its defense.

Furthermore, in the case of the last citation, the complaining resident was running a competing school facility in his residence. He did not lodge a complaint against the gymnasium.

Thus, because of the manner in which the ordinance was drafted, it became used in an arbitrary manner to restrict efforts of institutions concerned with serious music of various sorts as well as the intended disco clubs, and often affected such institutions to a greater degree. Examination of the database of citations and fines for the period 1988 to 1991 shows a pattern in which smaller jazz, folk, and classical-music cafes go out of business when cited, whereas large discos continue to operate, challenging each citation in the hearings, until they are forced to close. The discos often open under a new corporate identity, sometimes in the same location.

One dance club, located in an old recording studio in a high-density residential part of downtown New York, received its first two citations in 1988, and a third citation in 1990. In 1991 it got an additional citation under a different corporate name. That citation was dismissed. In 1994 it suddenly changed both its name and corporate identity, but not its format.

Some better-capitalized dance clubs have been able to operate without citation by instituting conventional noise-control measures, but also by modifying their music-reproduction systems. They have used frequency-selective limiting, created desired effects and sensations in less sensitive

bands (including the 31.5 and 40 Hz bands ignored by the ordinance) and used steering techniques in their loudspeaker systems. However, in doing so, each has had to purchase its own research, using its customer base as a laboratory and thus risking its viability. Nevertheless, these efforts have enabled them to operate within the statutory limits of the law but have not assured that they would operate without annoyance to the community.

As a result of these inconsistencies in the law, community cultural organizations and the American Federation of Musicians have petitioned city agencies to change the ordinances, but without definitive technical guidelines, have not been able to make concrete proposals.

Thus the ordinance, while having a little effect on the noise environment has had a detrimental effect on cultural activities. Nevertheless, its goal of protecting the community from fluctuating low-frequency noise needs to be considered by WG-11. The lack of international standardization in this area will be a problem.

Assuming progress is made in international standardization concerning low-frequency noise, what is left as the final task of the WG-11 working group is to specify music-performance-level guidelines. These guidelines should assist the proper identification of sources and the designation of limit values that will be effective in mitigating annoyance while maintaining the viability of the performance venues and taking into account available means for mitigation.

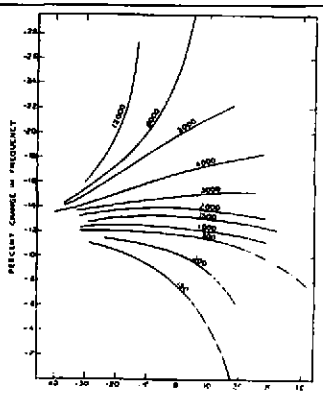
The task is manifold, embodying commercial, entertainment, and artistic questions. Because of the entertainment value of loud music, commercial establishments can be competitively penalized by arbitrary limit setting. For these establishments, such levels are derived from pleasure perception by the audiences. The nature of this pleasure and its spectral and temporal components has not been fully identified. Reasons such as the sensations of an adrenalin rush and visceral vibration have been given, however, cultural factors are often involved and can be identified.

These cultural factors often depend on the third question, the levels needed for artistic expression. A related question often confused with artistic need is the ability of the artists to hear their own performances and those of their fellow musicians. Improper acoustical and electroacoustical design can aggravate this problem and encourage a misconception that loud individual monitoring is the only solution.

However the levels required for performance are basically inherent in the music. Illustrative of one of many possible physical correllatives of this requirement, the literature shows that the pitch of a tone changes with loudness. However, the amount of change is different at different frequencies. Figure 1, from Stevens and Davis, *Hearing, Its Psychology and Physiology* (Acoustical Society of America, New York 1938) shows the amount that

various frequencies must be changed to maintain pitch as sound intensity changes.

As a result, music that sounds consonant when played loudly may sound dissonant when played softly. The authors point out that this effect is most severe with pure tones (such as are produced by many electronic musical instruments) and is often compensated for by musicians using traditional acoustical instruments.



Decibels (0 dB = 74 dB SPL)
Figure 1

A further difference due to the loudness at which an instrument is played is shown by Misciewicz and Rakowski, "Loudness of Musical Instruments," *Journal of the Acoustical Society of America*, 96:6 (New York, 1994) p 3378,

> ... The dynamic LL [loudness level] range of musical instruments depends not only on the dynamic SPL range but is also markedly influenced by the variations in spectral envelope that arise from gradations in playing level.

Thus, for example, Caribbean music — having derived from loud instruments played out-of-doors or in open structures — could lose its clarity if attempted to be played at the levels of the traditional music of colder climates that evolved mainly indoors in rooms sealed against the elements.

In summary, the AESSC WG-11 working group has the task of providing guidelines for artists, commercial establishments, and regulators in the control of noise created by musical performance. It has been guided by international standards for the measurement of the noise and for assessment of noise inmpact on hearing and community annoyance. It requires additional guidance regarding low-frequency noise. Finally, it must, by means of its own research, assess the levels required for performance.